SURFACE WATER

This sheet contains surface-water-discharge data. Annual discharge is separated to show overland flow; base flow; and maximum, mean, and minimum monthly flow. Flow-duration curves, low-flow frequency values, and climatological data also are included.

Discharge at Streamflow-Gaging Stations

The surface-water system in the study area consists of the head waters regions of six rivers and creeks, numerous artificial lakes, and extensive wetland areas. Nearly all surface-water areas are ground-water discharge areas; however, lakes in which the water levels are artificially elevated are ground-water recharge areas.

The USGS has maintained streamflow-gaging stations on Raccoon Creek near Swedesboro (01477120) since 1966, on the Maurice River at Norma (01411500) since 1932, and on the Great Egg Harbor River at Folsom (01411000) since 1925 (fig. 3-1). Variations in annual mean discharge for each gaging station are shown in figure 3-2. Annual mean discharge for each year through water year 1986 was divided into two components by using the sliding-interval streamflow- separation techniques described by Pettyjohn and Henning (1979). (A water year, typically used in hydrologic analyses, is from October 1 of the previous calendar year through September 30. In this report, years not identified as water years are calendar years.) The larger component of annual mean discharge is base flow, which consists of ground water that discharges to the stream. The smaller component consists of overland flow to surface-water bodies and precipitation that falls directly on them.

Annual base flow of the Maurice River ranged from 59.6 ft³/s in 1966 to 222 ft³/s in 1973, with a mean of 143 ft³/s. The base-flow component of total annual flow ranged from 74 percent to 92 percent, with a mean of 87 percent. Annual base flow of the Great Egg Harbor River ranged from 39 ft³/s in 1931 to 112 ft³/s in 1973, with a mean of 73 ft³/s. The base-flow component of total annual flow ranged from 79 to 89 percent, with a mean of 85 percent. The base-flow component for Raccoon Creek near Swedesboro consists of ground water from both the Kirkwood-Cohansey aquifer system and deeper aquifers. The annual base flow of Raccoon Creek ranged from 17.9 ft³/s in 1981 to 47.3 ft³/s in 1973, with a mean of 30.8 ft³/s. The base-flow component of total annual flow ranged from 64 percent to 83 percent, with a mean of 75 percent.

The minimum, mean, and maximum monthly discharges at the three gaging stations are shown in figure 3-3. Maximum and minimum discharges result from extremely high precipitation and severe droughts, respectively. The daily minimum, daily mean, and instantaneous maximum discharges for the period of record at the three gaging stations are given in table 3-1.

Figure 3-4 shows flow-duration curves for the three gaging stations. These graphs are used to determine the amount of time that the discharge equals or exceeds a given discharge during the period of record.

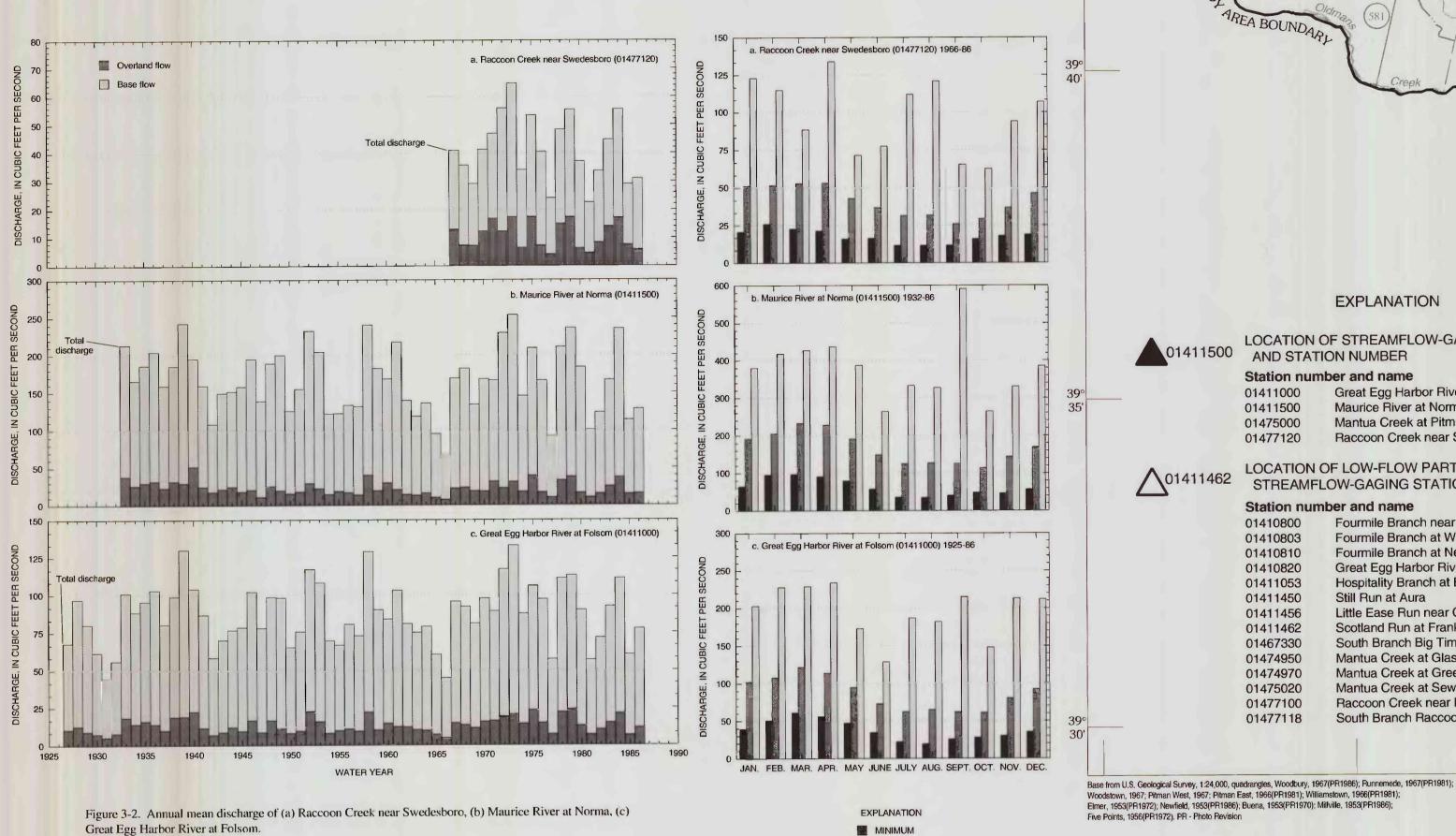
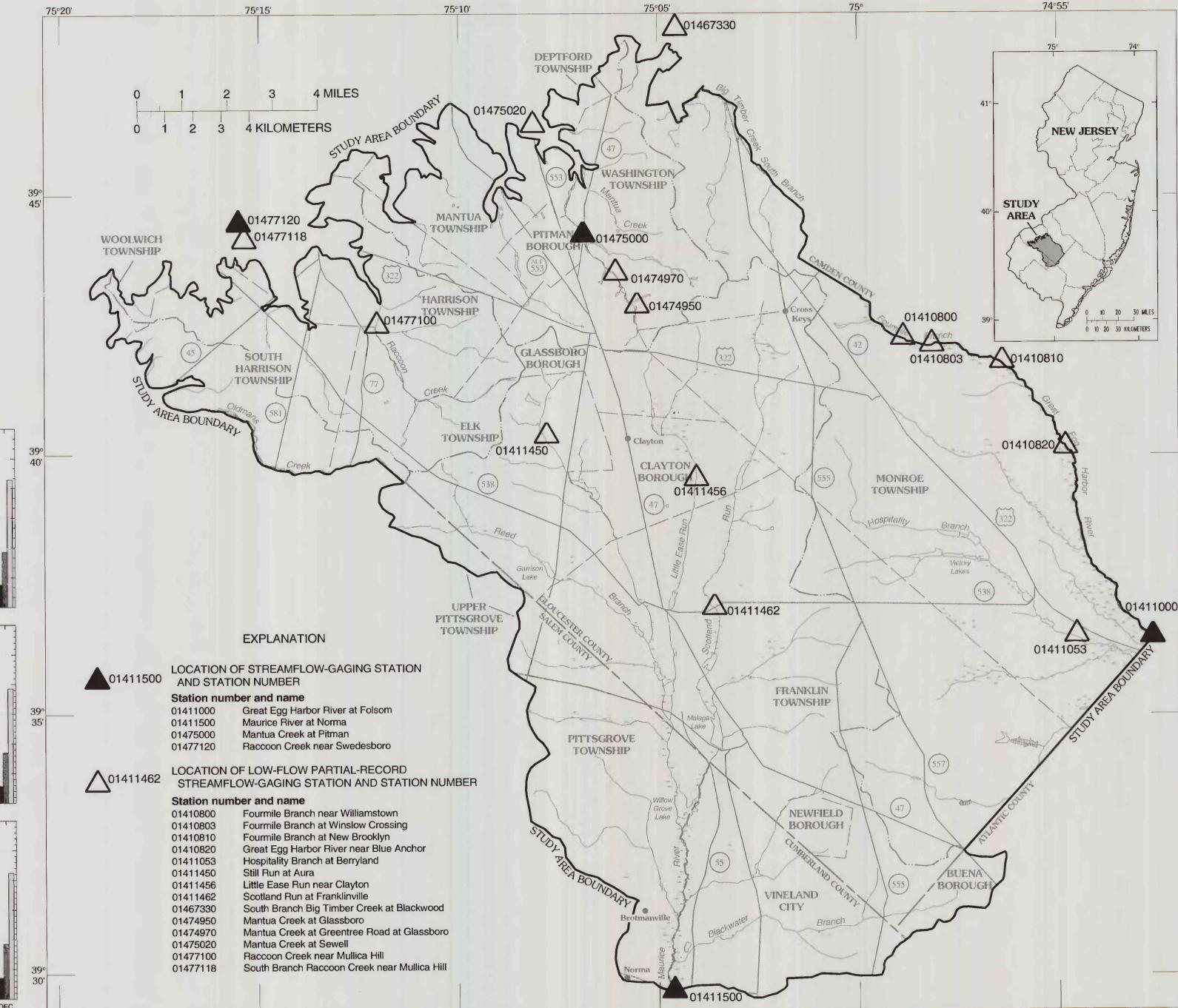


Figure 3-3. Minimum, mean, and maximum monthly discharge of (a) Raccoon Creek near Swedesboro, 1966-86; (b) Maurice River at Norma, 1932-86; (c) Great Egg Harbor River at Folsom, 1925-86.

MEAN ☐ MAXIMUM



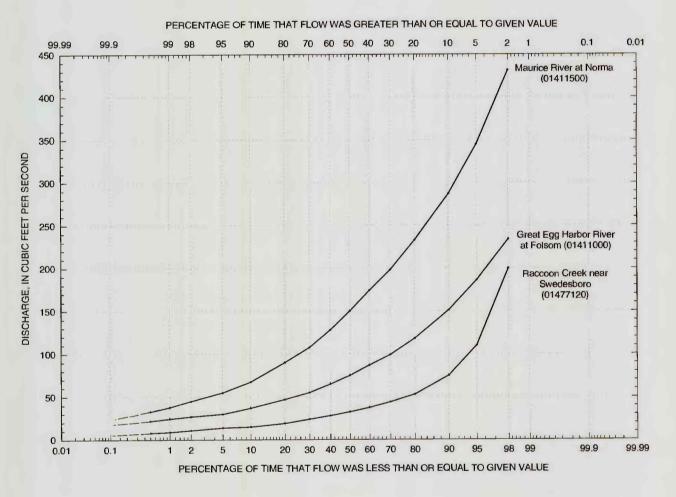


Figure 3-4. Flow-duration curves for daily flow of (a) Raccoon Creek near Swedesboro, 1966-86; (b) Maurice River at Norma, 1932-86; (c) Great Egg Harbor River at Folsom, 1925-86.

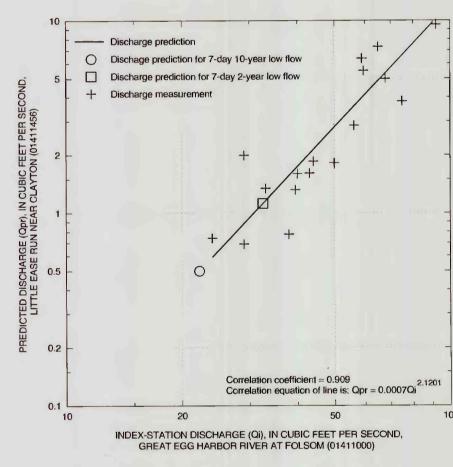


Figure 3-5. Low-flow correlation of Little Ease Run near Clayton and Great Egg Harbor at Folsom.

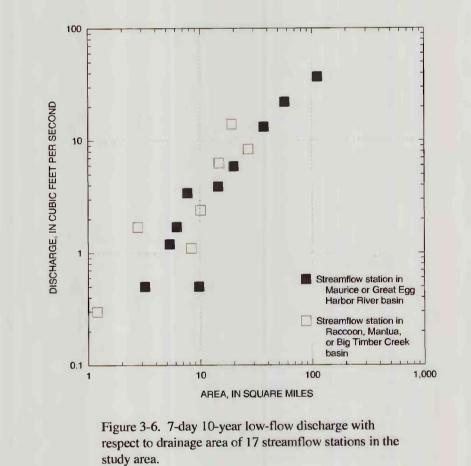


Figure 3-1. Locations of gaging stations and low-flow partial-record stations.

RELATION OF PRECIPITATION TO DISCHARGE AND EVAPOTRANSPIRATION

Precipitation is the sole source of water in the study area. Figure 3-7 shows the annual precipitation at Clayton for water years 1933 through 1986 based on data from the National Oceanic and Atmospheric Administration. Annual precipitation for the period of record ranged from a maximum of 68.64 in. in 1958 to a minimum of 27.73 in. in 1964, with a mean of 44.5 in. Minimum, mean, and maximum monthly precipitation values are given in figure 3-8A. Mean monthly precipitation is 3.5 in.

Precipitation leaves each basin primarily as stream discharge and evapotranspiration. The discharge of the Maurice River at Norma, shown in figure 3-7, as inches of precipitation over the basin, ranged from a maximum of 30.44 in. in 1973 to a minimum of 8.07 in. in 1966, with a mean of 20.01 in. Mean discharge accounts for approximately 45 percent of mean annual precipitation. The discharge of the Maurice River at Norma ranged from 73.8 percent to a minimum of 26.8 percent of annual precipitation.

The amount of water that leaves the basin through evapotranspiration (ET) was calculated by using the Thornthwaite equation (Thornthwaite and Wilm, 1944), which uses the mean monthly temperature (fig. 3-8B). Mean monthly potential ET is shown in figure 3-8C. Mean annual potential ET is 24.84 in., or 55 percent of mean annual precipitation.

Discharge at Low-Flow Partial-Record Stations

Base-flow discharge has been measured more than 10 times at 14 of the 15 low-flow partial-record stations in the study area (fig. 3-1) during the past 20 years. Where sufficient data are available, three low-flow correlation analyses were made for each site. Each low-flow correlation was made by correlating low-flow-discharge data at the partial-record site with the discharge at a gaging station (index station) at the time of the measurement.

An example of a low-flow correlation is given in figure 3-5. The regression line drawn through the data for partialrecord station 01411456 produces the following equation:

$Q_{pr} = 0.0007 \times Q_I^{2.1201}$

where Qpr is the discharge at the partial-record station and Q1 is the discharge at the index stations. This equation can be used to calculate the base-flow discharge at the partial-record station for any known base flow at the gaging station 01411000. The correlation coefficient for this analysis is 0.909. The 7-day, 2-year low-flow; 7-day, 10-year low-flow; and mean discharges for each partial-record station were calculated by using each low-flow correlation equation. The results are shown in table 3-1.

Low-flow correlation equations can be used as follows. In order to convert figure 3-2b, the graph of the annual mean discharge of the Maurice River at Norma (01411500), to a graph of the calculated annual mean discharge of Scotland Run at Franklinville (01411462), the low-flow correlation equation for these stations given in table 3-1 is used. The equation is $Q_{pr} = 0.0947 \times Q_1 = 1.0333$.

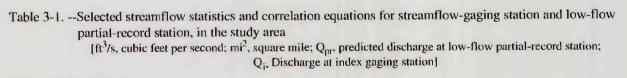
Correlation coefficients range from 0.0 to 1.0; the correlation increases as the coefficient approaches 1.0. By inserting the various discharge values of the Maurice River (25, 50, 75,...) from figure 3-2 for Ql in this equation, Qpr the range of discharges of Scotland Run at Franklinville, can be calculated. Therefore, where QI= 25 ft³/s, then

$Q_{pr} = 0.0947 \times 25 \cdot 1.0333$ $Q_{Dr} = 2.6 \text{ ft}^3/\text{s}.$

In this way, discharges for Scotland Run at Franklinville can be calculated from discharge data in figure 3-2a. In a similar manner, it is possible to convert discharges from figures 3-2 through 3-4 into discharges for each partial-record station listed in

Figure 3-6 is a plot of the 7-day, 10-year low-flow frequency values for the 17 of the surface-water stations in the study area against their respective drainage areas. The line drawn through the data points is a "best- fit" line based on the low-flow data from the partial-record stations in the study area. This plot can be used to estimate the 7-day, 10-year low-flow frequency discharge values for each ungaged stream for which the drainage area is known. For example, the Scotland Run watershed upstream from Willow Grove Lake comprises an area of about 29.8 mi². Therefore, from figure 3-6, the 7- day, 10-year frequency low flow is about 10 ft⁻³/s. The average daily discharge of any tributary of the Maurice or Great Egg Harbor Rivers can be calculated in a similar manner.





	Discharge (ft ³ /s)							
Gaging Station	7-day 2-year	7-day 10-year	Maximum	Daily Mean	Minimum	Area (mr²)		
01411000	32	22	1,400	86.3	15	57.1		
01411500	59	37	7,360	167	23	112		
01417500	6.1	4.1	470	11.5	2.6	6.05		
01477120	12	8.1	3,530	44.1	2.9	26.9		

			TREAMFLOW GAGIN		Discharge (ft ³ /s)			
Low-flow station Q _{pr}	Gaging station Qi	Correlation coefficient	Correlation equation		7-day 2-year Q _{pr}	7-day 10-year Q _{pr}	Mean Q_{pr}	Area (mi ²)
01410800	01411000	0.8868	$\Omega = 03136$	O: 1.137	1.6	1.1	5.0	5.34
01410600	01411500	.8624	Q_{pr} =.03136 Q_{pr} =.04392	Q _i 1.137 Q _i 0.9059	1.8	1.2	4.5	
01410803	01411000	.9224	$Q_{pr} = .1903$	Q _i ^{0.894} Q _i ^{0.97}	4.2	3.0	10.2	6.22
	01411500	.9040	$Q_{pr} = .05097$	Qi.97	2.7	1.7	7.3	
	01477120	.9253	$Q_{pr} = .05097$ $Q_{pr} = .12388$	Q _i 1.1889	2.4	1.6	10.3	
01410810	01411000	.9143	O _m =.1433	Qi 0.9669	4.1	2.8	7.1	7.74
	01411500	.8563	$\Omega = 2733$	0.099	4.7	3.4	9.8	
	01477120	.8055	Q_{pr} =.1433 Q_{pr} =.2733 Q_{pr} =.67603	Q_i^0 0.7508	4.4	3.3	11.0	
01410820	01411000	.9730	$Q_{pr} = .4871$	Qi 1.050	18.5	12.5	52.5	37.3
01410620	01477120	.9136	$Q_{pr}=2.3894$	Qi 0.9291	18.8	14.0	52.0	
01411050	01411000	0100	0 - 11052	Qi 1.2648	0.6	6.0	22.6	20.0
01411053	01411000	.9199	Q _{pr} =.11953	Qi 1.0624	9.6	6.0	33.6	20.0
	01411500	.9117	Q_{pr} =.11953 Q_{pr} =.12771 Q_{pr} =.14541	Qi 1.0624	9.7	5.9	29.4	
	01477120	.7496	$Q_{pr} = .14541$	Q _i 1.6509	8.8	4.9	67.1	
01411450	01411000	.8690	$Q_{pr} = .00327$	Qi 1.596	.8	.5	2.0	3.21
	01411500	.8978	$Q_{pr} = .00855$	Qi 1.1448	.9	.5	3.0	
	01477120	.8045	$Q_{pr} = .00242$	Q _i 1.1448 Q _i 2.2731	.7	.3	11.2	
01411456	01411000	.9090	Q _{pr} =.0007	Qi 2.1201	1.1	.5	8.9	9.77
01111150	01411500	.9057	$Q_{pr}=.001$	Qi 1.7269	1.1	.5	6.9	
	01477120	.7709	$Q_{pr} = .00123$	Qi 2.6474	.9	.3	23.0	
01411460	01411000	0375	0 07596	Qi 1.2746	6.3	3.9	22.3	14.8
01411462		.9375	$Q_{pr} = .07586$ $Q_{pr} = .0947$	Q _i 1.0333			18.8	14.0
	01411500	.8692	Q _{pr} =.0947	Qi 1.591	6.4	4.0		
	01477120	.8219	$Q_{pr} = .10678$		5.6	3.2	39.5	
01467330	01411000	.6706	$Q_{pr} = 1.417$	Qi 0.7086	16.5	12.7	33.5	19.1
	01411500	.9056	$Q_{pr} = 2.20387$	Qi 0.5301	19.1	14.9	33.2	
	01477120	.7194	$Q_{pr}=1.417$ $Q_{pr}=2.20387$ $Q_{pr}=2.894$	Q _i 0.7066	16.8	13.0	40.0	
01474950	01411000	.8897	$Q_{pr} = .003419$	Q _i 1.42 Q _i 1.3352 Q _i 1.337	.5	.3	1.9	1.2
	01411500	.9065	$Q_{pr} = .00211$	O:1.3352	.5 .5	.3	2.0	
	01477120	.8847	$Q_{pr} = .01687$	Q _i 0.1557	.0	.0	.0	
01474970	01411000	.8969	$Q_{pr} = .1107$	Qi 0.8957	2.5	1.8	6.0	2.78
	01411500	.9117	$Q_{pr} = .08161$	0.0419	2.5	1.7	6.1	
	01477120	.9509	$Q_{pr} = .2512$	Q _i 0.8973	2.3	1.7	7.0	
01475020	01411000	.9042	Q _{pr} =.3837	$Q_{i}^{0.8812}$ $Q_{i}^{0.7975}$	8.1	5.8	19.5	14.7
	01471200	.9640	$Q_{pr} = 1.272$	Q _i 0.7975	9.2	6.9	24.6	
01477100	01411000	.9260	$Q_{pr} = .037512$	Qi 1.347	4.0	2.4	15.2	10.1
01477100	01411500	.9443	$Q_{pr} = .03891$	Q _i 1.363	4.0	2.4	13,1	
01477118		.9190	Q _{pr} =.02116	Q _i ^{1.279} Q _i ^{1.1501}	1.8	1.1	6.4	8.3
	01411500	.9400	$Q_{pr} = .01711$	Q _i 1.213	1.9	1.1	6.2	
	01477120	.9694	$Q_{pr} = .1065$	Q _i	2.2	1.4	9.7	

HYDROLOGY OF THE UNCONFINED AQUIFER SYSTEM IN THE UPPER MAURICE RIVER BASIN AND ADJACENT AREAS IN GLOUCESTER COUNTY, NEW JERSEY, 1986-87

Pierre J. Lacombe and Robert Rosman

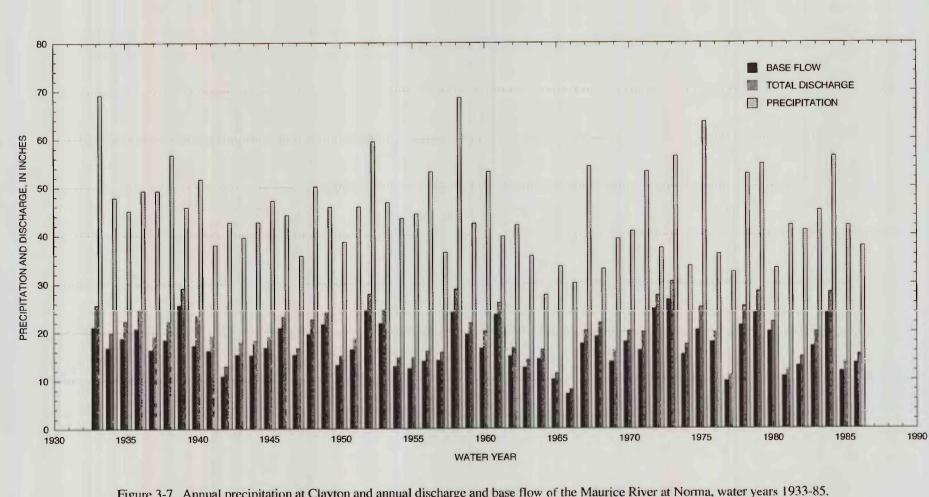


Figure 3-7. Annual precipitation at Clayton and annual discharge and base flow of the Maurice River at Norma, water years 1933-85.

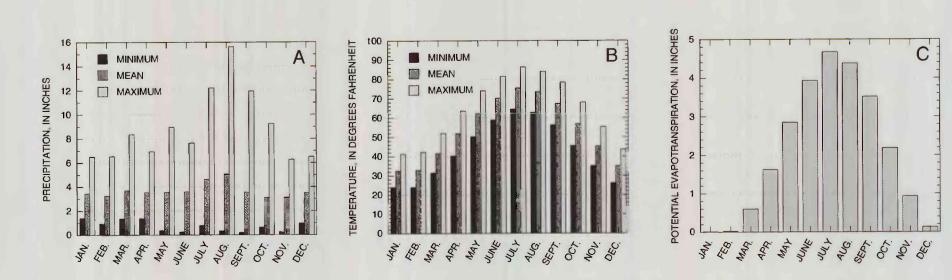


Figure 3-8. Minimum, mean, and maximum monthly (a) precipitation, (b) temperature, and (c) potential evapotranspiration at Clayton, 1933-85.